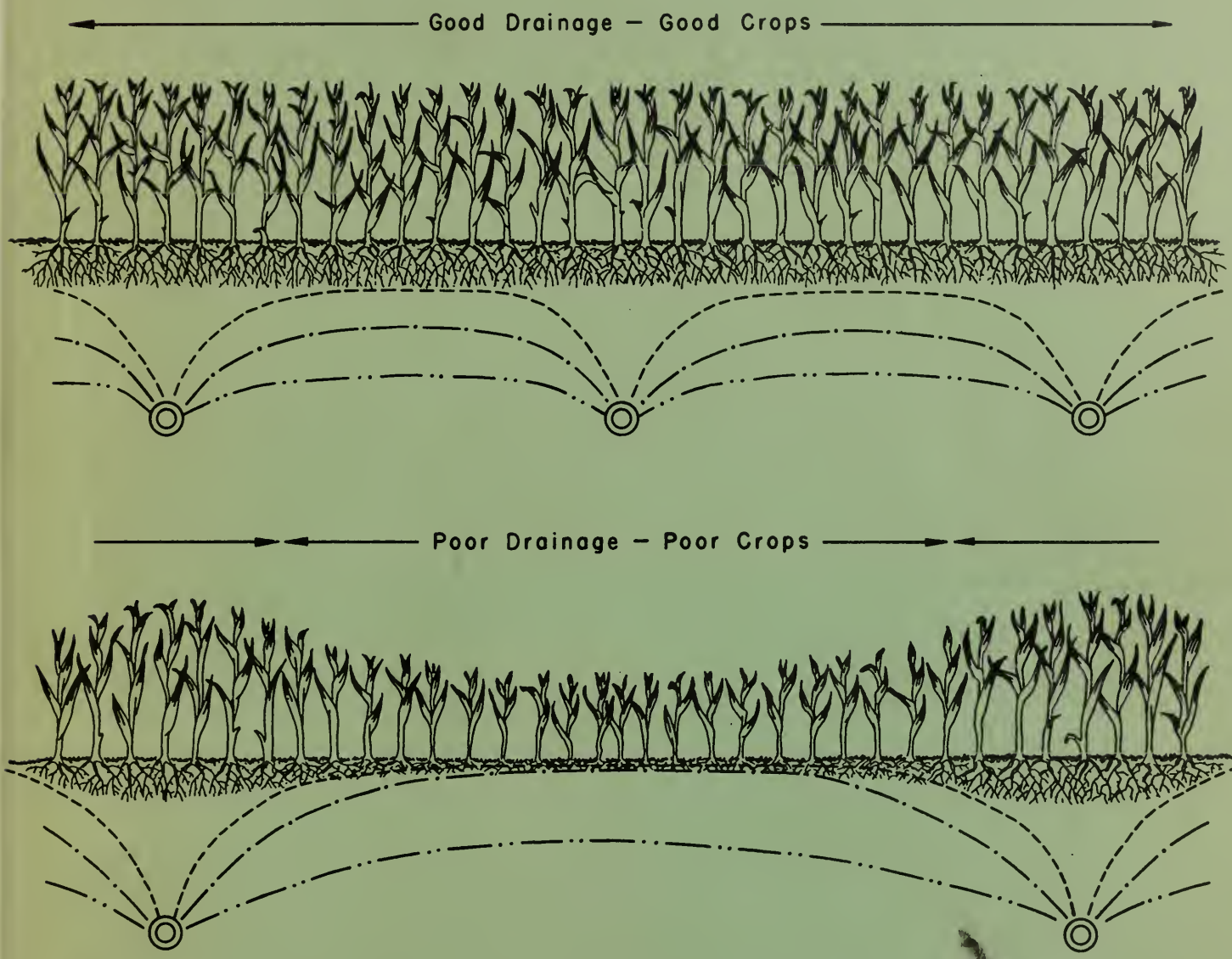
Vermont Drainage Guide



UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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PREFACE

The purpose of this guide is to present some of the basic criteria required for the planning of drainage improvements on the wet soils of Vermont. The information presented is based on the best currently available research data and experience of many SCS technicians.

This guide does not contain complete specifications for the design and construction of drainage works. It covers field drainage only and assumes that an adequate outlet exists or will be provided. Detailed design criteria may be found in the Vermont SCS Technical Guide and the Engineering Field Manual for Conservation Practices.

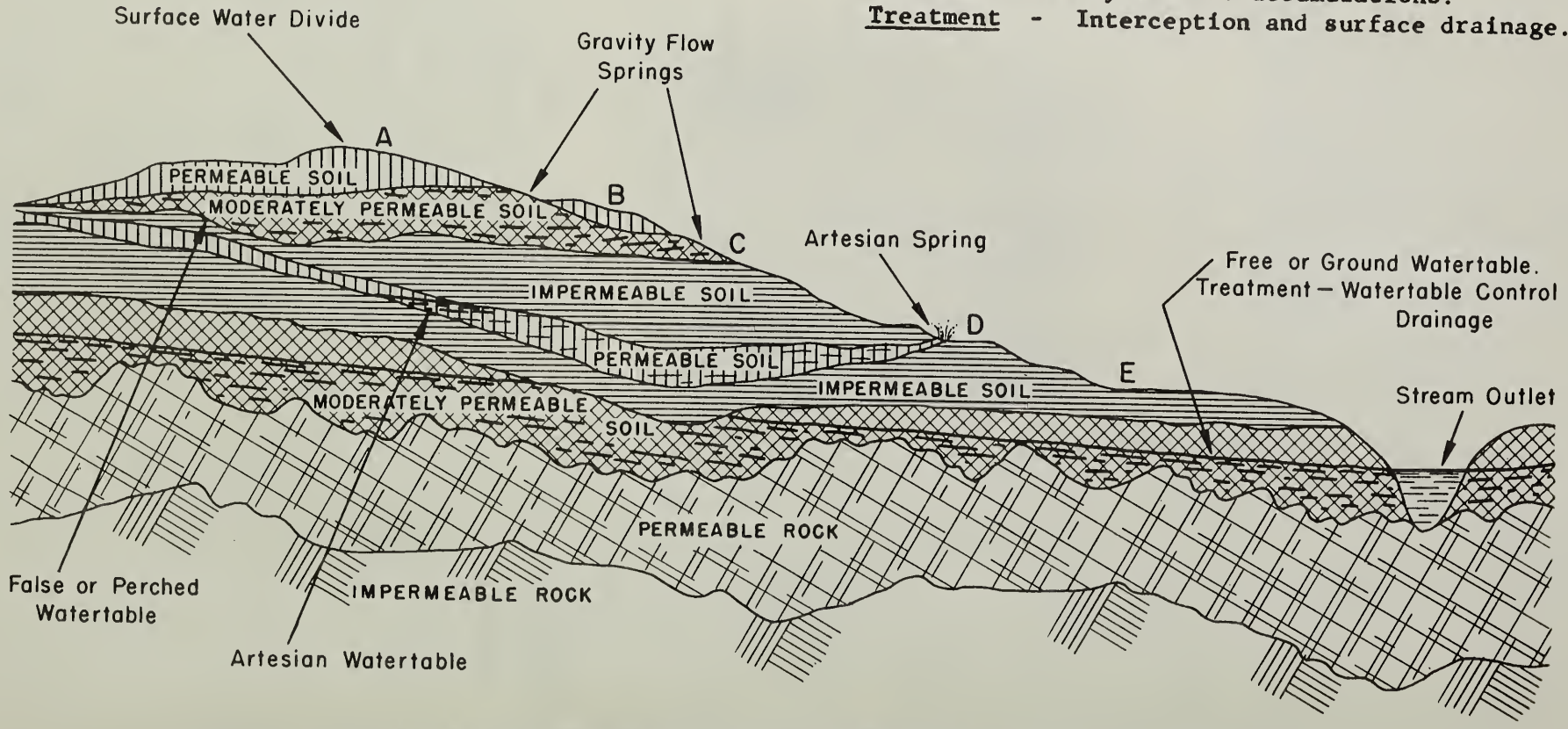
To be successful, a drainage system must be designed to fit the topography, crops, soils to be drained and the conservation tillage pattern of the farm. Different soils, slopes and combinations thereof require different methods and procedures. Generally, site conditions will require a combination of several kinds of drains. Therefore, this should be used as a guide only and must be supplemented with judgment and a thorough understanding of the principle of good drainage. The recommendations included herein have been made for all soils where it is felt that drainage will be effective. The economic feasibility of each project is determined by many local factors and should be decided only after a very careful analysis.

A - Infiltration of precipitation accumulates over less permeable subsoil. Some is diverted through aquifers to wet weather seeps at B. Seeps may completely dry out during droughty periods.
Treatment - Interception drainage.

C - Outcrop of false or perched watertable. Larger collecting area and more complete interception by impermeable soil gives longer flow to springs.
Treatment - Interception drainage. Occasionally, spring development.

D - Pressure head gives year-round even flow. Water can come from adjacent or remote watersheds. If this pressure flow is covered by a mantle of moderately permeable soil, a large area may be saturated. Water source often difficult to locate and confine. The permeable soil is an aquifer.
Treatment - Tile drainage.

E - Often heavy soils with flattening grades. Wetness caused by surface accumulations.
Treatment - Interception and surface drainage.



TYPICAL GROUND WATER MOVEMENT AND RECOMMENDED DRAINAGE PRACTICES

EXPLANATION OF CHARTS

(1) Drainage Group. Indicates grouping of soils having similar drainage characteristics. County soil legends must be used to correlate mapping unit numbers shown on soils maps with soils names.

(2) Soil Series. A listing of each soil in the group, by name.

(3) Unified Soil Classification. Symbols shown represent the classification which most commonly occurs in the soil profile.

(4) Tile Inflow Rate. The estimated amount of water which can be expected to enter the tile through the soil profile. Concentrated flows such as spring discharge, flow from open inlets, etc., must be added.

(5) Velocities. For areas of 640 or less, the suggested maximum design velocities for bare and vegetated earth channels, respectively.

(6) Major Problems or Hazards. Comment regarding the usual cause of drainage impediments. Localized areas may present additional problems, with varying severity.

(7) Percent Slope. Refers to the average land slope.

(8) Drainage Method. Self explanatory.

(9) Drainage Criteria. Indicates the method of determining capacity, using procedures given by the Engineering Field Manual for Conservation Practices. -- Curve indicates the recommended curve to be used for design capacity as shown on the drainage chart. Figures in inches are the recommended drainage coefficients for use in tile system design, representing the amount of water in inches to be removed in a 24 hour period. Q_{10} indicates capacity design to carry the 10 year - 24 hour frequency peak runoff.

(10) Depth in Inches. Depth of channel or tile invert expressed either as a range or a minimum.

(11) Spacing Range - Feet. Usual spacing of parallel surface or sub-surface drains. OSD means on-site-determination.

(12) Recommended Side Slopes. Side slope recommendations are self explanatory. Earliest possible application of recommended mulching and establishment of recommended side slope and/or channel vegetation is essential to erosion and sediment reduction.

OTHER TERMS

Tile

Popular term meaning a sub-surface drain constructed of materials such as clay or concrete, perforated bituminized fiber pipe, plastic or corrugated polyethylene drainage tubing.

Seep

The term indicates a significant wet zone (aquifer) which can be identified by test pits or augering. When depth is expressed by "seep + 4 inches," the 4 inches is measured below the seep.

Pan

Or "hardpan," referring to the dense, impervious soil layer or surface which may occur at shallow depth in many glaciated areas.

Permeability

Permeability is estimated for the soil as it occurs in place and is the saturated flow. The permeability listed is for the most restrictive layer in the soil profile. The classes are as follows:

Permeability class	Range in inches per hour
Very rapid	over 20.0
Rapid	6.3 to 20.0
Moderately rapid	2.0 to 6.3
Moderate	0.63 to 2.0
Moderately slow	0.2 to 0.63
Slow	0.06 to 0.2
Very slow	Less than 0.06

Natural Drainage Classes

Moderately Well Drained: Water is removed from the soil slowly enough so that the soil is wet for a short but significant time, usually during fall or spring. These soils commonly have a slow or very slow permeability, a seasonal high water table, additions of water through seepage, or a combination of these conditions. Mottling commonly occurs at 15 to 30 inches below the surface.

Somewhat Poorly Drained: Soils in this class are intermediate in drainage between the moderately well drained and poorly drained. Water is removed slowly enough so that the soil remains wet for a moderate period of time, usually during the spring and fall. These soils have a slow or very slow permeability, a seasonal high or perched water table, additions of water through seepage, or a combination of these conditions. Mottling commonly occurs within the surface layer and the upper part of the subsoil is grayish colored in places.

Poorly Drained: Water is removed so slowly that the soil remains wet for a long time. The water table or excess seepage water is commonly at or near the surface for 7 to 9 months of the year. The poorly drained condition is due to a high water table, a slow or very slow permeability, seepage, or a combination of these conditions. The subsoil is commonly gray and mottled. Since the soils are wet for a long time, the excess wetness inhibits the growth of field crops. Artificial drainage generally is needed for satisfactory crop production.

Very Poorly Drained: Water is removed from the soil so slowly that the soil is saturated throughout most of the year and the water table is at or near the surface. Soils in this class usually occupy depressional areas and are frequently ponded. Mucky surface layers are present in many areas and the subsoil is dominantly gray.

INDEX TO SOIL SERIES AND DRAINAGE GROUPS

SOILS NOT LISTED

For placement of soil series not included in this list consult the engineering or soil survey staff.

CAUTION

Positive identification of the soil series must be made during on-site study and evaluation.

(1) D R A I N A G E G R O U P A

Moderately well drained, loamy soils with a compact hardpan at less than 3½ feet. Slow to very slow permeability in hardpan. Glacial till.

(2) SOIL SERIES	(3) UNIFIED SOIL CLASSIFICATION	(4) TILE INFLOW RATE cfs/1000'	(5) VELOCITIES Ft./Sec. Bare	Vegetated	(6) MAJOR PROBLEMS OR HAZARDS
Buckland	ML	0.09	3.0	6.0	Seasonal high perched water table because of hardpan
Peru	SM, ML	0.09	3.5	6.0	
Peru, gray subsoil	SM, ML	0.09	3.5	6.0	
Pittstown	SM, ML	0.09	3.5	6.0	
Royalton	SM, ML	0.09	3.5	6.0	
Woodbridge	SM, ML	0.09	3.5	6.0	

(7) PERCENT SLOPE	(8) DRAINAGE METHOD	(9) DRAINAGE CRITERIA	(10) DEPTH IN INCHES	(11) SPACING RANGE-FEET	(12) RECOMMENDED SIDE SLOPES
1 - 15	Diversion	Q_{10}	Pan plus 4 inches	OSD	3:1 or flatter
1 - 3	Ditch - Interceptor	B Curve	Pan plus 4 inches	OSD	3:1 uphill, 1½:1 downhill
3 - 15	Ditch - Interceptor	Q_{10}	Pan plus 4 inches	OSD	3:1 uphill, 1½:1 downhill
1 - 15	Tile - Interceptor	.09 cfs/1000'	Down to pan, but minimum of 30 inches	OSD	- - - - - - -

(1) D R A I N A G E G R O U P B

Moderately well drained, loamy and silty soils without a hardpan. Moderate to moderately slow permeability. Glacial till and lake sediments.

(2) SOIL SERIES	(3) UNIFIED SOIL CLASSIFICATION	(4) TILE INFLOW RATE cfs/1000'	(5) VELOCITIES Ft./Sec. Bare	Vegetated	(6) MAJOR PROBLEMS OR HAZARDS
Amenia	ML	0.07	3.0	6.0	Seep areas and seasonal high fluctuating water table.
Belgrade	ML	0.09	2.0	5.0	
Georgia	ML	0.09	3.5	6.0	
Nicholville	ML	0.09	2.0	5.0	
Scio	ML	0.09	2.0	5.0	
Sutton	SM, ML	0.09	3.5	6.0	
Waumbek	SM, ML	0.09	3.5	6.0	

(7) PERCENT SLOPE	(8) DRAINAGE METHOD	(9) DRAINAGE CRITERIA	(10) DEPTH IN INCHES	(11) SPACING RANGE-FEET	(12) RECOMMENDED SIDE SLOPES
1 - 3	Ditch - Interceptor	B Curve	Seep + 4"	OSD	3:1 Uphill, 1:1 Downhill
3 - 15	- Interceptor	Q_{10}	Seep + 4"	OSD	3:1 Uphill, 1:1 Downhill
3 - 15	Diversion	Q_{10}	Seep + 4"	OSD	3:1 or flatter
1 - 3	Ditch - Random	C Curve	24" +	OSD	1:1
1 - 3	- Surface Drainage	None	12" +	OSD	4:1 or flatter
1 - 3	Land Smoothing	- - -	Cut and fill for grade to outlet	---	- - - - - - - - - -
1 - 2	Tile - System	3/8"	30" - 42"	80 - 300	- - - - - - - - - -
1 - 2	- Random	See Column 4**	30" - 42"	OSD	- - - - - - - - - -
1 - 15	- Interceptor *	See Column 4	Intercept seep, Minimum 30"	OSD	- - - - - - - - - -

Remarks: The Belgrade, Nicholville, and Scio series have a low liquid limit and the silty and very fine sandy loam material flows readily when wet. Tile trenches and ditch banks slough readily when wet. The soil material may flow into and plug tile drains. Installation of tile drains during drier periods of the year reduces the hazard of sloughing of trench walls.

* Backfill trench with porous material to seep.

** Consider 3/8" coefficient when possible future use as outlet for additional tile lines exists.

(1) D R A I N A G E G R O U P C

Somewhat poorly and poorly drained loamy soils with a compact, slowly permeable hardpan at less than 3½ feet. Glacial till.

(2) SOIL SERIES	(3) UNIFIED SOIL CLASSIFICATION	(4) TILE INFLOW RATE cfs/1000'	(5) VELOCITIES Ft./Sec. Bare	Vegetated	(6) MAJOR PROBLEMS OR HAZARDS
Cabot	ML, SM	0.09	3.5	6.0	Seasonal high perched water table because of hardpan. Ponding in depressional areas.
Ridgebury	ML, SM	0.09	3.5	6.0	
Stissing	ML, SM	0.09	3.5	6.0	

(7) PERCENT SLOPE	(8) DRAINAGE METHOD	(9) DRAINAGE CRITERIA	(10) DEPTH IN INCHES	(11) SPACING RANGE-FEET	(12) RECOMMENDED SIDE SLOPES
0 - 3	Ditch - Interceptor	B Curve	Pan + 4" Up to 36"	Perimeter	1½:1
	- Random	B Curve	Pan + 4" Up to 36"	OSD	1½:1 or flatter
	- Surface Drainage	None	12" +	OSD	4:1 or flatter
	Land Smoothing	- - -	Cut and fill for grade to outlet	---	- - - - - - -
	Tile - System	3/8"	30"	40 - 80	- - - - - - -
	- Random	0.09 cfs/1000'	30"	OSD	- - - - - - -
	- Interception *	0.09 cfs/1000'	Down to pan, Minimum 30"	OSD	- - - - - - -
3 - 15	Diversion	Q_{10}	Pan + 4"	OSD	3:1 or flatter
	Ditch - Interceptor	Q_{10}	Pan + 4"	OSD	3:1 Uphill, 1½:1 Downhill
	Tile - Interceptor *	See Column 3	Down to pan, Minimum 30"	OSD	- - - - - - -

* Backfill trench with porous material to seep.
** Consider 3/8" coefficient when possible future use as outlet for additional tile line exists.

USDA-SCS-HYATTSVILLE, MD 1972

(1) D R A I N A G E G R O U P D

Somewhat poorly to poorly drained, loamy and silty soils without a hardpan. Glacial till and lake sediments.

(2) SOIL SERIES	(3) UNIFIED SOIL CLASSIFICATION	(4) TILE INFLOW RATE cfs/1000'	(5) VELOCITIES Ft./Sec. Bare	Vegetated	(6) MAJOR PROBLEMS OR HAZARDS
Canandaigua	ML, CL	0.05	2.5	5.0	High water table in poorly
Kendaia	ML, SM	0.07	3.0	6.0	drained and very poorly
Leicester	ML, SM	0.09	3.5	6.0	drained soils and seasonal
Massena	ML, SM	0.07	3.0	6.0	high water table in some-
Monarda	ML	0.07	3.5	6.0	what poorly drained soil-
Munson	ML over CH	0.05	2.0	5.0	
Norfleet	ML	0.08	2.5	5.0	
Raynham	ML	0.08	2.0	5.0	
Raynham, gray subsoil variant	ML	0.08	2.0	5.0	

(7) PERCENT SLOPE	(8) DRAINAGE METHOD	(9) DRAINAGE CRITERIA	(10) DEPTH IN INCHES	(11) SPACING RANGE-FEET	(12) RECOMMENDED SIDE SLOPES
2 - 15	Diversion	Q_{10}	Minimum 12"	OSD	3:1 or flatter
1 - 3	Ditch - Interceptor	B Curve	Seep + 4" or Minimum 24"	OSD	3:1 Uphill, $1\frac{1}{2}$:1 Downhill
3 - 15	- Interceptor	Q_{10}	Seep + 4" or Minimum 24"	OSD	3:1 Uphill, $1\frac{1}{2}$:1 Downhill
1 - 3	- Surface Drainage	None	12"	OSD	4:1 or flatter
1 - 3	Land Smoothing	- - -	Cut and fill for grade to outlet	---	- - - - - - -
1 - 3	Tile - Random	See column 4**	30" Minimum	OSD	- - - - - - -
1 - 15	- Interceptor *	See Column 4	In aquifer, Minimum 30"	OSD	- - - - - - -

Remarks: The Canandaigua, Norfleet, and Raynham series have a low liquid limit and the silty and very fine sandy loam material flows readily when wet. Tile trenches and ditch banks slough readily when wet and the soil material may flow into and plug tile drains. Installation of tile during drier periods of year reduces the hazard of sloughing of trench walls.

* Backfill trench with porous material to seep.
** Consider 3/8" coefficient when possible future use as outlet for additional tile line exists.

USDA-SCS-WATKINS, MD 1972

(1) D R A I N A G E G R O U P E

Very poorly drained loamy and silty soils. Peacham and Whitman have hardpan within 2 feet of surface. Glacial till and lake sediments.

(2) SOIL SERIES	(3) UNIFIED SOIL CLASSIFICATION	(4) TILE INFLOW RATE cfs/1000'	(5) VELOCITIES Ft./Sec. Bare	Vegetated	(6) MAJOR PROBLEMS OR HAZARDS
Birdsall	ML-CL, ML	0.08	2.0	5.0	High water table and ponding of water.
Burnham	ML, SM	0.07	3.0	5.0	
Lyons	ML, CL, OL	0.07	3.0	5.0	
Mansfield	ML, SM, OL	0.09	3.5	5.0	
Massena, gray subsoil	ML, SM	0.07	3.0	5.0	
Peacham	ML, SM, SP-SM, OH	0.09	3.5	5.0	
Whitman	SM, SP-SM, OL, OH	0.09	3.5	5.0	

(7) PERCENT SLOPE	(8) DRAINAGE METHOD	(9) DRAINAGE CRITERIA	(10) DEPTH IN INCHES	(11) SPACING RANGE-FEET	(12) RECOMMENDED SIDE SLOPES
0 - 1	Ditch - Water table control	C Curve	Pan + 4", Minimum 30"	100 - 300	1½:1
	- Random	C Curve	24"	OSD	1½:1
	Tile - Random	See Column 4 **	30" Minimum	OSD	- - - - - - -
1+	Ditch - Interceptor	C Curve	30"	OSD	1½:1
	Tile - Interceptor *	See Column 4	Pan + 4", Minimum 30"	OSD	- - - - - - -

Remarks: The Birdsall series has a low liquid limit, and the silty and very fine sandy loam material flows readily when wet. Tile trenches and ditch banks slough readily when wet and the soil material may flow into and plug tile drains. Installation of tile drains during the drier periods of the year reduces the hazard of sloughing of trench walls.

* Backfill trench with porous material to seep.
** Consider 3/8" coefficient when possible future use as outlet for additional tile line exists.

(1) D R A I N A G E G R O U P F

Moderately well drained clayey soils with slow to very slow permeability. Lake sediments.

(2) SOIL SERIES	(3) UNIFIED SOIL CLASSIFICATION	(4) TILE INFLOW RATE cfs/1000'	(5) VELOCITIES Ft./Sec. Bare	Vegetated	(6) MAJOR PROBLEMS OR HAZARDS
Buxton	ML over CH or MH	0.05	2.0	4.5	Slow or very slow permeability.
Vergennes	MH, CH	0.02	1.5	4.0	

(7) PERCENT SLOPE	(8) DRAINAGE METHOD	(9) DRAINAGE CRITERIA	(10) DEPTH IN INCHES	(11) SPACING RANGE-FEET	(12) RECOMMENDED SIDE SLOPES
0 - 2	Ditch - Interceptor	B Curve	Seep + 4", or depth for capacity	Perimeter	2:1 or flatter
	- Surface Drainage	None	12"	300	4:1 or flatter
	Land Smoothing	- - -	Cut and fill for grade to outlet	---	- - - - - - - -
	Tile - System	3/8"	30"	30 - 70	- - - - - - - -
	- Random	See Column 4 *	30" Minimum	OSD	- - - - - - - -
2 - 15	Diversion	Q_{10}	Depth for capacity	200 - 600	3:1 or flatter
2 - 3	Ditch - Surface Drainage	None	12"	OSD	4:1 or flatter
2 - 3	Land Smoothing	- - -	Cut and fill for grade to outlet	---	- - - - - - - -
2 - 15	Tile - Interceptor	See Column 4	30" Minimum	OSD	- - - - - - - -

* Consider 3/8" coefficient when possible future use as outlet for additiohal tile lines exists.

(1) D R A I N A G E G R O U P G

Poorly drained, clayey soils with very slow or slow permeability. Loamy material underlies the Panton, loamy subsoil variant. Lake sediments.

(2) SOIL SERIES	(3) UNIFIED SOIL CLASSIFICATION	(4) TILE INFLOW RATE cfs/1000'	(5) VELOCITIES Ft./Sec. Bare	Vegetated	(6) MAJOR PROBLEMS OR HAZARDS
Covington	MH, CH	0.05	1.5	4.0	Slow or very slow permeability and ponding in places
Covington, variant	MH, CH	0.05	1.5	4.0	
Panton	MH, CH	0.02	1.5	4.0	High water table.
Panton, variant	MH, CH, CL	0.05	1.5	4.0	
Panton, loamy subsoil	CH or MH over SM	0.07	1.5	4.0	
Scantic	ML over CH or MH	0.05	2.0	4.5	

(7) PERCENT SLOPE	(8) DRAINAGE METHOD	(9) DRAINAGE CRITERIA	(10) DEPTH IN INCHES	(11) SPACING RANGE-FEET	(12) RECOMMENDED SIDE SLOPES
0 - 2	Ditch - Interceptor	B Curve, Corn; C, Hay-Pasture	Seep + 4", or depth for capacity	Perimeter	2:1 or flatter
	- Surface Drainage	None	12"	300	4:1 or flatter
	Land Smoothing	- - -	Cut and fill for grade to outlet	---	- - - - - - -
	Tile - System	3/8"	30"	30 - 70	- - - - - - -
	- Random	See Column 4*	30" Minimum	OSD	- - - - - - -
2 - 15	Diversion	Q_{10}	Depth for capacity	200 - 600	3:1 or flatter
	Ditch - Surface Drainage	None	12"	OSD	4:1 or flatter
	Land Smoothing	- - -	Cut and fill for grade to outlet	---	- - - - - - -
	Tile - Interceptor	See Column 4	30" Minimum	OSD	- - - - - - -

Remarks: The Covington, variant; Panton, variant; and Panton, loamy subsoil are present in Franklin County and possibly in Grand Isle County. They have a lower content of clay than the typical Covington and Panton soils, and therefore respond more readily to tile drainage.

* Consider 3/8" coefficient when possible future use as outlet for additional tile exists.

(1) D R A I N A G E G R O U P H

Very poorly drained, clayey soils with very slow permeability. Lake sediments.

(2) SOIL SERIES	(3) UNIFIED SOIL CLASSIFICATION	(4) TILE INFLOW RATE cfs/1000'	(5) VELOCITIES Ft./Sec. Bare	Vegetated	(6) MAJOR PROBLEMS OR HAZARDS
Biddeford	ML over CH or MH	0.05	2.0	4.5	Very slow permeability and ponding hazard.
Livingston	MH, CH, OH	0.02	1.5	4.0	High water table.
Livingston, variant	MH, CH, OH	0.05	1.5	4.0	

(7) PERCENT SLOPE	(8) DRAINAGE METHOD	(9) DRAINAGE CRITERIA	(10) DEPTH IN INCHES	(11) SPACING RANGE-FEET	(12) RECOMMENDED SIDE SLOPES
0 - 1	Ditch - Interceptor	C Curve	To mineral soil + 4", with depth for capacity	Perimeter	1½:1
	- Surface Drainage	None	12"	300	1½:1
	Land Smoothing	- - - -	Cut and fill for grade to outlet	---	- - - - - - -
	Tile - Random	See Column 4*	30"	OSD	- - - - - - -

* Consider 3/8" coefficient when possible future use as outlet for additional tile exists.

(1) D R A I N A G E G R O U P I

Moderately well drained soils comprised of sandy or loamy material over clays or sandy material over loamy and silty material. Rapid or moderately rapid permeability in upper layers and slow or very slow in underlying layers. Lake sediments.

(2) SOIL SERIES	(3) UNIFIED SOIL CLASSIFICATION	(4) TILE INFLOW RATE cfs/1000'	(5) VELOCITIES Ft./Sec. Bare	Vegetated	(6) MAJOR PROBLEMS OR HAZARDS
Eldridge	SP-SM, SM, ML	0.15	2.0	5.0	Seasonal high perched water table because of finer textured underlying material.
Elmwood	SM over CH or MH	0.10	2.0	5.0	
Elmwood, coarse variant	SP-SM, SM over CH, MH	0.10	2.0	5.0	
Elmwood, silty subsoil	SM over ML	0.15	2.0	5.0	

(7) PERCENT SLOPE	(8) DRAINAGE METHOD	(9) DRAINAGE CRITERIA	(10) DEPTH IN INCHES	(11) SPACING RANGE-FEET	(12) RECOMMENDED SIDE SLOPES
1 - 15	Diversion	Q_{10}	Silt or Clay + 4"	300 - 500	3:1 or flatter
1 - 3	Ditch - Interceptor	B Curve	Silt or Clay + 4"	OSD	3:1 Uphill, 1:1 Downhill
3 - 15	- Interceptor	Q_{10}	Silt or Clay + 4"	OSD	3:1 Uphill, 1:1 Downhill
1 - 3	- Random	B Curve, corn; C, hay-pasture	Silt or Clay + 4" or 36"	OSD	1:1 or flatter
1 - 3	- Surface Drainage	None	12"	OSD	4:1 or flatter
1 - 3	Land Smoothing	- - - -	Cut and fill for grade to outlet	----	- - - - - - -
1 - 3	Tile - Random	See Column 4 **	30" Minimum	OSD	- - - - - - -
3 - 15	- Interceptor *	See Column 4	To silt or clay, minimum 30"	OSD	- - - - - - -

Remarks: The silty material underlying the Eldridge and Elmwood, silty subsoil series has a low liquid limit and flows readily when wet. Tile trenches and ditch banks slough readily when wet and the soil material may flow into and plug tile drains. Installation of tile during the drier periods of the year reduces the hazard of sloughing of trench walls.

* Backfill trench with porous material to seep.

** Consider 3/8" coefficient when possible future use as outlet for additional tile line exists.

(1) D R A I N A G E G R O U P J

Poorly drained soils comprised of loamy material over clays or sandy material over silty material. Rapid or moderately rapid permeability in upper layers and slow to very slow in underlying material. Lake sediments.

(2) SOIL SERIES	(3) UNIFIED SOIL CLASSIFICATION	(4) TILE INFLOW RATE cfs/1000'	(5) VELOCITIES Ft./Sec. Bare	Vegetated	(6) MAJOR PROBLEMS OR HAZARDS
Eldridge, wet variant	SM over ML	0.15	2.0	5.0	High water table and slow to very slow permeability in underlying material.
Enosburg	SP-SM, SM over ML	0.15	2.0	5.0	
Swanton	SM over CH, MH	0.10	2.0	5.0	

(7) PERCENT SLOPE	(8) DRAINAGE METHOD	(9) DRAINAGE CRITERIA	(10) DEPTH IN INCHES	(11) SPACING RANGE-FEET	(12) RECOMMENDED SIDE SLOPES
0 - 1	Ditch - Interceptor	B Curve, corn; C, hay-pasture	Silt or Clay + 4"	Perimeter	1:1
	- Random	B Curve, corn; C, hay-pasture	Silt or Clay + 4" or 36"	OSD	1:1
	- Surface Drainage	None	12"	300	4:1 or flatter
	Land Smoothing	- - - - -	Cut and fill for grade to outlet	---	- - - - - -
	Tile - Random	See Column 4 **	30"	OSD	- - - - - -
1 - 15	Diversion	Q_{10}	12"	300 - 500	3:1 or flatter
1 - 3	Ditch - Interceptor	B Curve, corn; C, hay-pasture	Silt or Clay + 4"	OSD	1:1
3 - 15	- Interceptor	Q_{10}	Silt or Clay + 4"	OSD	3:1 Uphill, 1:1 Downhill
1 - 3	- Surface Drainage	None	12"	OSD	4:1 or flatter
1 - 3	Land Smoothing	- - - - -	Cut and fill for grade to outlet	---	- - - - - -
1 - 15	Tile - Interceptor *	See Column 4	To silt or clay, minimum 30"	OSD	- - - - - -

Remarks: The silty material underlying the Enosburg and Eldridge, wet variant series has a low liquid limit and flows readily when wet. Tile trenches and ditch banks slough readily when wet and the soil material may flow into and plug tile drains. Installation of tile during drier periods of the year reduces the hazard of sloughing of trench walls.

* Backfill trench with porous material to seep.

** Consider 3/8" coefficient when possible future use as outlet for additional tile line exists.

(1) D R A I N A G E G R O U P K

Very poorly drained soils comprised of loamy material over clays. Moderately rapid permeability in upper layers and very slow permeability in underlying material. Lake sediments.

(2) SOIL SERIES	(3) UNIFIED SOIL CLASSIFICATION	(4) TILE INFLOW RATE cfs/1000'	(5) VELOCITIES Ft./Sec. Bare	Vegetated	(6) MAJOR PROBLEMS OR HAZARDS
Whately	SM over CH or MH	0.10	2.0	5.0	High water, ponding hazard, and very slow permeability in underlying material.

(7) PERCENT SLOPE	(8) DRAINAGE METHOD	(9) DRAINAGE CRITERIA	(10) DEPTH IN INCHES	(11) SPACING RANGE-FEET	(12) RECOMMENDED SIDE SLOPES
0 - 3	Ditch - Interceptor	C Curve	Silt or Clay + 4"	OSD	1:1
	- Water table Control	- - - -	Silt or Clay + 4" or 30"	200 - 500	1:1
	- Random	D Curve	Silt or Clay + 4" or 30"	OSD	1:1
	- Surface Drainage	None	12"	OSD	4:1 or flatter
	Land Smoothing	- - - -	Cut and fill for grade to outlet	- - -	- - - - - -

(1) D R A I N A G E G R O U P L

Moderately well drained sandy soils with rapid permeability. Water-deposited sandy and gravelly material and loamy alluvial soils.

(2) SOIL SERIES	(3) UNIFIED SOIL CLASSIFICATION	(4) TILE INFLOW RATE cfs/1000'	(5) VELOCITIES Ft./Sec. Bare	Vegetated	(6) MAJOR PROBLEMS OR HAZARDS
Croghan	SP, SM	0.15	2.5	5.0	Seasonal high water table or springs.
Deerfield	SP, SM, GP, GM	0.15	2.5	5.0	
Duane	SP, SM, GP, GM	0.15	2.5	5.0	
Hero	SM over SP, SP-SM	0.15	2.5	5.0	
Ninigret	SM over SP, SP-SM	0.15	2.5	5.0	
Podunk	SM over SP-SM, SM	0.15	2.5	5.0	
Sudbury	SM over SP, SP-SM	0.15	2.5	5.0	

(7) PERCENT SLOPE	(8) DRAINAGE METHOD	(9) DRAINAGE CRITERIA	(10) DEPTH IN INCHES	(11) SPACING RANGE-FEET	(12) RECOMMENDED SIDE SLOPES
0 - 15					
0 - 3	Ditch - Interceptor	B Curve, corn; C, hay-pasture	Seep + 4"	OSD	3:1 Uphill, 1:1 Downhill
3 - 15	- Interceptor	Q_{10}	Seep + 4"	OSD	3:1 Uphill, 1:1 Downhill
0 - 3	- Random	B Curve, corn; C, hay-pasture	24" minimum to 48"	OSD	1:1
0 - 3	- Surface Drainage	None	12"	OSD	4:1 or flatter
0 - 3	Land Smoothing	- - - -	Cut and fill for grade to outlet	---	- - - - - -
0 - 3	Tile - Random	.15 cfs/1000'	30"	OSD	- - - - - -
0 - 15	- Interceptor *	.15 cfs/1000'	Intercept Seep, Minimum 30"	OSD	- - - - - -

Remarks: If underlying material is very gravelly or very coarse sands the tile inflow rate will probably be .25 to .30. On-site review essential.

* Backfill trench with porous material to seep.

(1) D R A I N A G E G R O U P M

Somewhat poorly to poorly drained sandy soils with rapid permeability. Water-deposited sandy and gravelly material and loamy alluvium.

(2) SOIL SERIES	(3) UNIFIED SOIL CLASSIFICATION	(4) TILE INFLOW RATE cfs/1000'	(5) VELOCITIES Ft./Sec. Bare	Vegetated	(6) MAJOR PROBLEMS OR HAZARDS
AuGres	SP, SP-SM	0.15	2.5	5.0	High water table or springs.
Fredon	SM over SP, SP-SM	0.15	2.5	5.0	
Rumney	SM over SP-SM, SM	0.15	2.5	5.0	
Walpole	SM over SP, SP-SM	0.15	2.5	5.0	
Walpole, non-acid	SM over SP, SP-SM	0.15	2.5	5.0	
Wareham	SM over SP, SP-SM	0.15	2.5	5.0	

(7) PERCENT SLOPE	(8) DRAINAGE METHOD	(9) DRAINAGE CRITERIA	(10) DEPTH IN INCHES	(11) SPACING RANGE-FEET	(12) RECOMMENDED SIDE SLOPES
0-3 Minor areas	Ditch - Interceptor	C Curve	Seep + 4"	OSD	3:1 Uphill, 1:1 Downhill
3-15	- Water table Control	- - - - -	24" Minimum to 48"	200 - 500	1:1
	- Random	- - - - -	24" Minimum to 48"	OSD	1:1
	- Surface Drainage	None	12"	OSD	4:1 or flatter
	Land Smoothing	- - - - -	Cut and fill for grade to outlet	---	- - - - - -
	Tile - System	C = 3/8"	30" minimum	100 - 120	- - - - - -
	- Random	.15 cfs/1000' **	30" minimum	OSD	- - - - - -
	- Interceptor *	.15 cfs/1000'	Intercept seep, Minimum 30"	OSD	- - - - - -

Remarks: If underlying material is very gravelly or very coarse sands the tile inflow rate will probably be .25 to .30. On-site review essential.

* Backfill trench with porous material to seep.
** Consider 3/8" coefficient when possible future use as outlet for additional tile exists.

(1) D R A I N A G E G R O U P N

Very poorly drained sandy soils with rapid permeability. Water-deposited sandy and gravelly material.

(2) SOIL SERIES	(3) UNIFIED SOIL CLASSIFICATION	(4) TILE INFLOW RATE cfs/1000'	(5) VELOCITIES Ft./Sec. Bare	Vegetated	(6) MAJOR PROBLEMS OR HAZARDS
Halsey	SP-SM, SM, OL	0.15	2.5	5.0	High water table and ponding.
Scarboro	SP-SM, SM, SP, SW	0.15	2.5	5.0	

(7) PERCENT SLOPE	(8) DRAINAGE METHOD	(9) DRAINAGE CRITERIA	(10) DEPTH IN INCHES	(11) SPACING RANGE-FEET	(12) RECOMMENDED SIDE SLOPES
0 - 3	Ditch - Interceptor	C Curve	Seep + 4"	OSD	3:1 Uphill, 1:1 Downhill
	- Water table Control	- - - - -	24" Minimum to 48"	200 - 500	1:1
	- Random	- - - - -	24" Minimum to 48"	OSD	1:1
	- Surface Drainage	None	12"	OSD	4:1 or flatter
	Land Smoothing	- - - - -	Cut and fill for grade to outlet	---	- - - - - -
	Tile - System	C = 3/8"	30" minimum	100 - 120	- - - - - -
	- Random	.15 cfs/1000' **	30" minimum	OSD	- - - - - -
	- Interceptor *	.15 cfs/1000'	Intercept seep, Minimum 30"	OSD	- - - - - -

Remarks: If the underlying material is very gravelly or very coarse sands the tile inflow rate will probably be .25 to .30. On-site review is essential.

* Backfill trench with porous material to seep.
** Consider 3/8" coefficient when possible future use as outlet for additional tile line exists.

(1) D R A I N A G E G R O U P O

Moderately well drained silty alluvial soils with moderate permeability. Subject to flooding.

(2) SOIL SERIES	(3) UNIFIED SOIL CLASSIFICATION	(4) TILE INFLOW RATE cfs/1000'	(5) VELOCITIES Ft./Sec. Bare	Vegetated	(6) MAJOR PROBLEMS OR HAZARDS
Winooski	ML	0.07	2.5	5.0	Seasonal high water table and occasional flooding hazard.

(7) PERCENT SLOPE	(8) DRAINAGE METHOD	(9) DRAINAGE CRITERIA	(10) DEPTH IN INCHES	(11) SPACING RANGE-FEET	(12) RECOMMENDED SIDE SLOPES
0 - 3	Ditch - Interceptor	B Curve, corn; C, hay-pasture	24" Minimum to 48"	OSD	1:1
	- Random	B Curve, corn; C, hay-pasture	24" Minimum to 48"	OSD	1:1
	- Surface Drainage	None	12"	OSD	4:1 or flatter
	Land Smoothing	- - - -	Cut and fill for grade to outlet	---	- - - - - -
	Tile - Random	.07 cfs/1000'	30" minimum	OSD	- - - - - -

Remarks: The Winooski series have a low liquid limit and the silty and very fine sandy loamy material flows readily when wet. Tile trenches and ditch banks slough readily when wet and the soil material may flow into and plug tile drains. Installation of tile drains during drier periods of the year reduces the hazard of sloughing of trench walls.

(1) D R A I N A G E G R O U P P

Poorly drained silty alluvial soils with moderate to slow permeability. Subject to flooding.

(2) SOIL SERIES	(3) UNIFIED SOIL CLASSIFICATION	(4) TILE INFLOW RATE cfs/1000'	(5) VELOCITIES Ft./Sec. Bare	Vegetated	(6) MAJOR PROBLEMS OR HAZARDS
Limerick	ML	0.06	2.5	5.0	High water table, ponding, and a flooding hazard.
Wayland	ML	0.06	2.5	5.0	

(7) PERCENT SLOPE	(8) DRAINAGE METHOD	(9) DRAINAGE CRITERIA	(10) DEPTH IN INCHES	(11) SPACING RANGE-FEET	(12) RECOMMENDED SIDE SLOPES
0 - 3	Ditch - Interceptor	B Curve, corn; C, hay-pasture	24" Minimum to 48"	OSD	1:1
	- Random	B Curve, corn; C, hay-pasture	24" Minimum to 48"	OSD	1:1
	- Surface Drainage	None	12"	OSD	4:1 or flatter
	Land Smoothing	- - - -	Cut and fill for grade to outlet	---	- - - - - -
	Tile - Random	.06 cfs/1000'	30" minimum	OSD	- - - - - -

Remarks: The soils in this group have a low liquid limit and the soil material flows when wet. Tile trenches and ditch banks slough in readily when wet and the soil material may flow into and plug tile drains. Installation of tile drains during drier periods of the year reduces the hazard of sloughing of trench walls.

(1) D R A I N A G E G R O U P Q

Very poorly drained silty alluvial soils with variable permeability. Subject to flooding.

(2) SOIL SERIES	(3) UNIFIED SOIL CLASSIFICATION	(4) TILE INFLOW RATE cfs/1000'	(5) VELOCITIES Ft./Sec. Bare	Vegetated	(6) MAJOR PROBLEMS OR HAZARDS
Saco	ML, OL	0.04	2.5	5.0	High water table and flooding hazard. Subject to ponding.
Saco, sandy variant	ML, OL over SP, SP-SM	0.15	2.5	5.0	

(7) PERCENT SLOPE	(8) DRAINAGE METHOD	(9) DRAINAGE CRITERIA	(10) DEPTH IN INCHES	(11) SPACING RANGE-FEET	(12) RECOMMENDED SIDE SLOPES
0 - 1	Ditch - Random	C or D Curve	24" Minimum to 48"	OSD	1:1
	- Surface Drainage	None	12"	OSD	4:1 or flatter
	Land Smoothing	- - - - -	Cut and fill for grade to outlet	---	- - - - - -

(1) DRAINAGE GROUP R

Very poorly drained, organic soils and soils with loamy material over organic muck or peat.

(2) SOIL SERIES	(3) UNIFIED SOIL CLASSIFICATION	(4) TILE INFLOW RATE cfs/1000'	(5) VELOCITIES Ft./Sec. Bare	Vegetated	(6) MAJOR PROBLEMS OR HAZARDS
Carlisle	PT	0.15	2.5	-	High water table, subsides and oxidizes readily, and outlets difficult to obtain.
Markey	PT	0.15	2.5	-	
Muck and Peat	PT	0.15	2.5	-	
Muck, moderately deep	PT over sandy material	0.15	2.5	-	
Wallkill	ML over PT	0.15	2.5	-	

(7) PERCENT SLOPE	(8) DRAINAGE METHOD	(9) DRAINAGE CRITERIA	(10) DEPTH IN INCHES	(11) SPACING RANGE-FEET	(12) RECOMMENDED SIDE SLOPES
0 - 1	This group occurs under conditions which produce complex problems not covered in this guide. Drainage of soils in this group should be considered on an individual job basis.				

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